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Engineering Design File

Landfill Leachate Collection System Design Analysis

Idaho National Engineering and Environmental Laboratory

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ENGINEERING DESIGN FILE

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5. Summary:

The U.S. Department of Energy (DOE) authorized a remedial design/construction work plan for the Idaho National Engineering and Environmental Laboratory (INEEL) including the Idaho Nuclear Technology and Engineering Center (INTEC) in accordance with the Waste Area Group 3 Operable Unit (OU) 3-13 Record of Decision (ROD). The ROD requires contaminated surface soils to be removed and disposed of on-Site in the INEEL CERCLA Disposal Facility (ICDF). Infrastructure associated with the landfill includes an evaporation pond system and a leachate collection system. This engineering design file (EDF) provides the design calculations and assumptions for the design and installation of a leachate collection system.

The leachate collection system design analysis includes the following: leachate collection piping and pumps, design of the two crest pad buildings, and design of a secondary containment sump.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

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ABSTRACT

The leachate collection system was designed to meet applicable or relevant and appropriate requirements as specified in the Performance Criteria for the INEEL CERCLA Disposal Facility. The design of the INEEL CERCLA Disposal Facility features a disposal cell and two evaporation ponds for treatment of leachate and additional process water. The operation of the landfill is phased with Cell 1 operating initially followed by the future addition of Cell 2. The leachate collection system was designed to be expandable to incorporate Cell 2. The system was designed to accommodate maintenance and sampling activities through two crest pad buildings, one at the location of the landfill cell and one at the location of the evaporation ponds.

The leachate collection system design analysis includes calculations and discussion of the following: leachate collection piping and pumps, design of the two crest pad buildings, and design of a secondary containment sump.

CONTENTS

ACRONYMS

ALR	action leakage rate
AOS	apparent opening size
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AWG	American wire gauge
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	cubic meters per second
DOE	Department of Energy
EDF	engineering design file
EMT	electrical metallic tubing
FLA	full load amperage
FS	factor of safety
GFI	ground fault interceptor
gpm	gallons per minute
HDPE	high-density polyethylene
HELP	Hydraulic Evaluation of Landfill Performance
HVAC	heating, ventilating, and air conditioning
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LCRS	leachate collection recovery system
LDRS	leak detection recovery system
MCC	motor control center
NEC	National Electrical Code
NOAA	National Oceanic and Atmospheric Administration

OU	operable unit
PLDRS	primary leachate detection recovery system
PVC	polyvinylchloride
RA	remedial action
RD	remedial design
RGS	rigid galvanized steel
ROD	Record of Decision
SLRDS	secondary leak detection recovery system
SPC	specification
TDH	total dynamic head
THWN	Thermoplastic Heat Resistant Wet Location-Rated Nylon Cover
TW	Thermoplastic Wet Location-Rated
USACE	U.S. Army Corps of Engineers
XHHW	Cross Linked Thermoset High Heat Wet Location-Rated

Landfill Leachate Collection System Design

1. DESIGN CRITERIA

The leachate collection system was designed to be in compliance with the OU-13 Record of Decision (ROD) applicable or relevant and appropriate requirements (ARAR) as outlined in Department of Energy (DOE) Specification (SPC)-332 Performance Specification for the INEEL CERLCA Disposal Facility (ICDF) and evaporation pond.

The primary criterion for design of the leachate system is that all leachate be collected and removed from the landfill at a rate sufficient to prevent a hydraulic head greater than 12 in. from occurring at any point over the lining system. The system is designed to remove the accumulation of storm water resulting from a 25-year, 24-hour storm, within 72 hours. Other design criteria include the following:

- Bottom of the leak detection layer and the leachate collection layer is sloped at a minimum 2%.
- Granular drainage layer is 1 ft thick with hydraulic conductivity > 1 x 10^{-2} cm/s.
- The system must be designed to minimize clogging.
- The system is located above seasonally high water table.
- System must be designed to handle the runoff from a 25-year, 24-hour storm.
- Sumps and liquid removal systems must be of sufficient size to prevent back up into the drainage layer. The leachate collection recovery system (LCRS) sump capacity has been designed to provide approximately 9,300 gallons of storage.
- System components that come into contact with waste must be chemically resistant to that waste.
- System components must have sufficient strength and thickness to resist collapse.
- System components outside the limits of Cell 1 or the evaporation pond areas must have provisions for secondary containment.

2. LEACHATE COLLECTION PIPING

The ICDF landfill is designed such that leachate and precipitation within the operations area flows to a leachate sump at the north end of the Phase 1 cell. System piping and pumps will be sized to handle maximum leachate during the entire landfill operation life including the addition of Cell 2. The landfill liner was designed with a composite barrier to prevent leakage. Aspects of leachate collection design piping include the following: required piping and the spacing of piping, pipe size for maximum flow rate, pipe strength, and slot size compatibility with LCRS gravel. These design elements are discussed below.

2.1 Spacing of Leachate Collection Pipes

The U.S. Army Corps of Engineers Waterway Experiment Station: Hydraulic Evaluation of Landfill Performance (HELP) modeling of leachate percolation and collection in the bottom drainage layer, presented in the "Leachate Generation Study" (EDF-ER-269) established that the distance from the extreme corner of the landfill to a single central leachate collection pipe will be 520 ft or less, and that drainage of the maximum leachate flow predicted will result in a head buildup over the liner of far less than 1 ft at any point. This analysis included the worst-case condition for both phases: Cell 1 and Cell 2 (see Drawing P-301). Therefore, a central leachate collection pipe will be used running north-south in the bottom of each landfill cell. This pipe will be expandable such that the Cell 1 central leachate collection pipe may be connected to the future Cell 2 central collection pipe concurrent with the construction phases of Cell 2. In order to intercept higher flows from side slope drainage when no waste is in place on the side slopes, a collector pipe will be placed on the northern, and a geonet drainage layer will be placed over the primary liner on the eastern, and western inflection line, where the 3:1 side slope meet the landfill bottom.

2.2 Collection Pipe Size for Maximum Flow Rate

The perforated leachate pipes that convey leachate to the pump sump were sized using Manning's equation (as described in Sharma and Lewis 1994) for gravity flow with a roughness factor as recommended by the pipe manufacturer, to confirm that the 12-in. pipe can carry the maximum flow rate (see Appendix A). The maximum leachate flow will likely occur when cells are empty due to lack of waste moisture attenuation. When the landfill fills up, leachate volumes will drop off.

2.3 Collection Pipe Strength

Pipe wall thickness was selected based on maximum fill height such that the pipe will not fail due to excessive deflection, wall buckling, or wall crushing. Also considered in determining pipe strength was the live load for equipment when the liner is being placed above the piping. The Iowa formula was used to compute the load and deflection of the pipe (as outlined in Sharma and Lewis 1994). Pipe strength was reduced for perforations in accordance with the procedure outlined in Sharma and Lewis 1994. Calculations are presented in Appendix A. The pipe material assumed is made from resin meeting the requirements of ASTM D1248: Type III, Category 5, Class C, Grade 34 resin; PE3408 pipe with a cell classification of 345434C or better. The flexural modulus and material strength of the pipe was per manufacturers' published literature based on this classification of pipe. Crushing and buckling were also checked with the procedure outlined in Sharma and Lewis (1994) and pipe manufacturers' recommended design procedures.

2.4 LCRS Gravel

As discussed in Section 1, the design criteria for the LCRS gravel is required to have a hydraulic conductivity greater than 10^{-2} cm/sec. Native alluvium material from the Cell 1 ICDF excavation has been stockpiled for use as leachate collection gravel. The alluvium material consists of well-graded gravel and sand with a maximum fines content (percent passing the No. 200 standard U.S. sieve) of 10%. Data from the ICDF geotechnical report (DOE-ID 2000a) indicated variability in the hydraulic conductivity of the alluvium material, with results ranging from 1.8×10^{-3} cm/sec to 2.9×10^{-1} cm/sec. To ensure that the native material will achieve the required hydraulic conductivity, it will be processed to remove all material finer than a No. 10 standard U.S. sieve (2 mm).

Hydraulic conductivity lab tests were performed on samples of the alluvium material obtained during ICDF Cell 1 excavation to verify the hydraulic conductivity value. Tests were performed in rigid wall cells in conformance with ASTM D2434. Tests were performed both on native (unprocessed) samples and on samples processed to remove material finer than a No. 10 standard U.S. sieve. Results are provided in Appendix A. Gradations for both the native and processed alluvium are included with the filter criteria calculations in Appendix A.

Results indicated that the unprocessed samples had a hydraulic conductivity of 5×10^{-2} cm/sec. The processed samples had hydraulic conductivity value ranging from 0.9 to 1 cm/sec. We concluded from this testing that the native alluvium processed to remove material finer than a No. 10 standard U.S. sieve can easily achieve the design criteria hydraulic conductivity. The upper size limit for the gravel was set at 2 in. to prevent overly large material from being supplied. The 2-in. maximum size will ensure the gravel can be easily placed and will adequately conform to all design grades and spaces in the leachate collection system. Based on the gradation of the LCRS gravel, the D_{10} size varies from 4.5 to 5.0 mm. LCRS gravel compatibility was checked against pipe slot size. The results are included in Appendix A.

2.5 Filter Criteria

Filtering to prevent fines from clogging the leachate collection gravel, pipe, and pump will be accomplished through proper selection of the gradation for the LCRS gravel and overlying operation layer to allow filtering of fines and prevent clogging of the gravel. A separation (filter) geotextile would be required if the natural filtration properties of these materials were inadequate. Filter criteria calculations for the LCRS system are provided in Appendix A.

The filter criteria analysis concluded that the material proposed for the operations layer (native alluvium) and the LCRS gravel (see Section 2.4) provided an adequate natural filter and a separation geotextile is not required above the LCRS gravel. The analysis assumed the worst-case waste soil with high fines (greater than 50% passing the No. 200 standard U.S. sieve) was placed over the operations layer and proper filter criteria was still achieved. However, it is recommended that the first 2 ft of waste soil placed over the operations layer be limited to a maximum fines content of 20% to limit the possibility of future clogging of the LCRS gravel. If this select fill is not available for the initial lift, a separation geotextile could be used on top of the operations layer for filtration of fines from the waste. Operational procedures will be established to select the most granular material available for this initial lift. The waste material criteria and placement will be addressed in the Operations and Maintenance Manual.

3. LEACHATE PUMP ANALYSES

Based on performance specifications, pumps are required for removal of leachate that accumulates above the primary lining system and removal of any leachate that leaks into the leak detection systems in both the Phase 1 cell and the Evaporation Ponds. General pump criteria are described below and Appendix B contains detailed hydraulic calculations for pump sizing.

3.1 Phase 1 Cell Leachate Pumps

The Phase 1 Cell requires four pumps: one low-flow pump (LCRS) for regular pumping of leachate to the evaporation ponds, one high-flow pump in the event of a large storm (25-year/24-hour criteria) exceeding the capacity of the low-flow pump (LCRS), and one pump each in the leak detection systems (LDRS and secondary leachate collection recovery system [SLDRS]) in the event any water—leachate or consolidation/condensation water—accumulates in these systems and requires removal.

For convenience and operational versatility, roller-mounted pumps were selected for all leachate collection and detection systems. This type of pump can be lowered into the leachate sump through a carrier pipe and removed as needed. The advantages of a removable pump include easy access for maintenance and inspection, interchangeability of parts for the same pump models, and the ability to use one pump for transfer from one evaporation pond to another or to a truck load facility. A fixed, mounted sump pump may be more appropriate for continuous pumping operations from a manhole; however, the leachate sumps for the ICDF must be removable from the bottom liner areas when the landfill is filled.

Carrier piping for pump insertion and removal is sized appropriately based on manufacturer recommendations. The flow indicators and controllers in the Crest Pad Building are used to monitor and adjust flow within the leachate system. Because the building sits at the edge of the landfill cell and the side slope of the cell to the leachate sump is 3:1, the riser pipe entering the building will bend to transition from the side slope to the wall penetration location.

3.1.1 LCRS Low-flow Pump

Selection of a low-flow pump was based on the average leachate flow from the landfill as determined in the "Leachate Generation Study" (EDF-ER-269). According to calculations using the U.S. Army Corps of Engineers Waterways Experiment Station HELP model calculations, the maximum leachate flow based on monthly data is approximately 5 gallons per minute (gpm). Sizing the pump for slightly more flow will allow a margin of safety. Actual pumping rates will vary as the head losses and elevations of input and output water levels vary during the pumping cycle. Note that the HELP model also reports a peak daily amount for leachate production. This value (around 25 gpm) was not used because it represents one peak event, whereas the low-flow pump should be designed to pump on a routine basis with a factor of safety (FS) to handle larger flows. Peak events will be handled by the high-flow pump described below. The hydraulics of the low-flow pump were modeled and a pump was selected based on the hydraulic characteristics of the piping system (system curve) and the required flow rate. The detailed calculations are attached in Appendix B.

3.1.2 LCRS High-Flow Pump

Selection of a high-flow pump was based on the predicted water level in the sump and performance specifications. The high-flow pump is sized to allow pumping of the volume of water falling as precipitation in the largest open area of the landfill (Cell 2 area, 306,900 ft^2) resulting from a 25-year, 24-hour storm. The design storm for this event is the 25-year recurrence, 24-hour storm event, which is 1.73 in. (Sagendorf 1996), resulting in a storm surge volume of approximately 330,950 gallons. Based on precedents from similar landfill designs, the pumping system must be designed to draw down this surge volume from an open cell in 72 hours or less. The high-flow pump capacity necessary to accomplish removal of this volume of water is approximately 77 gpm. The pump selected should have a capacity somewhat greater than this estimated capacity. A significant safety factor is not needed for this pump because the design condition is a 25-year, 24-hour storm occurring at a point in time when the open landfill produces the highest leachate flow for a given precipitation input, which is an unlikely concatenation of events. Also, an oversized pump could cycle too quickly and/or create severe localized draw down in the gravel area surrounding the pump inlet screen, resulting in cavitation problems.

Calculation of total dynamic head (TDH) at the maximum flow rate was needed to select the high-flow pump. The pump selected has an estimated flow rate of 82 gpm, resulting in a factor of safety of 1.1 for the maximum design condition. The pipe sweep radius for the pump access riser is shown in the drawings.

3.1.3 LDRS and SLDRS Pumps

The same pump used for the LCRS low-flow pump will also be used for the leak detection systems. The action leakage rate (ALR), which defines the action rate for the leak detection system, was calculated in the "Leachate Generation Study" (EDF-ER-269) as 1,380 gallons/day or 0.97 gpm. This 1,380 gallons/day is equivalent to 98 gallons per acre per day (gpad), including both Cells 1 and 2. Therefore, the approximately 10-gpm capacity low-flow 0pump selected will be more than adequate to remove this flow rate. Using the same model pump will allow the same spare parts to be used for the LCRS low-flow and LDRS/SLDRS pumps.

3.2 Evaporation Pond Leachate Pumps

The evaporation ponds require three pumps: one pump in each of the east and west evaporation ponds' LDRS in the event any water accumulates in these systems, and one pump to transfer leachate between the west and east evaporation ponds or to transfer leachate from one of the ponds to the truck load station for transport. The same roller-mounted pumps and carrier piping systems for the Phase 1 cell were used for the evaporation pond pumps. Detailed hydraulic calculations and pump sizing are included in Appendix B.

3.2.1 LDRS Pumps—East and West Ponds

An ALR for the evaporation pond was calculated to determine the criteria for choosing a pump. The calculations are shown below.

3.2.1.1 Evaporation Pond Action Leakage Rate. The ALR is defined in the Final Rule (EPA 1992b, 40 CFR Part 264.222) as the "maximum design flowrate that the leak detection system...can remove without the fluid head on the bottom liner exceeding 1 ft." This calculation was performed to determine the ALR for the evaporation pond. The evaporation pond for the ICDF consists of two cells each with an area of approximately 1.5 acres. EPA provides generic ALR values of 1,000 gallons/acre/day (gpad) for surface impoundments (EPA 1992b). Results for the ALR were compared to the generic values provided by EPA.

EPA provides a formula (equation 1) based on Darcy's Law for calculating Action Leakage flow capacity, assuming that the liquid originates from a single hole in the primary liner (EPA 1992b):

$$Q = k\tan(\alpha)\beta \tag{1}$$

Where

Q = flow rate in leak detection system (LDS) per acre

k = hydraulic conductivity of drainage medium in LDS

H = head on secondary liner

α = slope of LDS

β = width of flow in LDS, perpendicular to flow direction.

The major uncertainty associated with this formula is determining the value of β, which is a complex function. Additional information is provided by EPA in a background document (EPA 1992b). By assuming that the shape of the wetted area downslope from the hole is parabolic, EPA rewrites equation 1 as equation 2:

$$Q = kD(2H-D) \tag{2}$$

Where

D = thickness of drainage layer

Other parameters are the same as in equation (1).

The drainage layer in the evaporation pond LDS consists of 1-ft thickness of leachate drain gravel. The head on the liner is defined as 1 ft per 40 CFR 264.222. The regulations require the drainage layer to have a minimum hydraulic conductivity of 0.1 cm/sec. As detailed in Section 2.4, the processed native alluvium that will be used as leachate drain gravel will have a hydraulic conductivity of 1 centimeter per second (cm/sec). However, to allow for long-term reduction of the hydraulic conductivity the ALR is calculated using the minimum guidance value of 0.1 cm/sec. This provides a one order of magnitude safety factor for drainage layer hydraulic conductivity in the calculations.

3.2.1.2 Action Leakage Rate Results. Using equation (2) and the assumed input parameters, the ALR for each evaporation pond is 1,590 gallons per day. This value includes a factor of safety of 2 in accordance with EPA guidelines (EPA 1992b). Details of the calculation are presented below. Using the generic value for surface impoundments provided by EPA of 1,000 gpad, the ALR = 1,000 × 1.5 acres or around 1,500 gallons per day for each evaporation pond cell, which agrees with the calculated value. This result forms the basis for the design of the evaporation pond leak detection system sump and pump shown in equation (3).

Action Leakage Rate for ICDF:

$$Q = kD(2H-D) \tag{3}$$

Where

Q = flow rate in LDS (per acre)

k = hydraulic conductivity of drainage medium in LDS

D = thickness of drainage layer in LDS

H = head on secondary liner

At the ICDF:

k = 0.1 cm/sec = 0.001m/sec

D = 0.3048 m

H = 0.3048 m.

Therefore

Q = 0.000093 m^3/acre/sec

Q = 2,120 gpad

Apply Factor of Safety   2 per EPA guidance

Action Leakage Rate   1,060 gpad x 1.5 acre = 1,590 gallons per day.

The same approximate flow rate criteria (10 gpm) for selecting LDRS pumps for the Phase 1 cell was used to select LDRS pumps for the evaporation ponds, except that a pump was chosen with a lower head output to fit the elevation and head loss requirements for pumping from the evaporation pond LDRS sump location to the truck load station.

3.2.2 Leachate Transfer Pump

A pump is required to transfer leachate between the east and west evaporation ponds for the unlikely event that leakage is detected in one pond and must be transferred to the other pond while the leak is found and fixed. Also, a pump could be necessary to transfer leachate from either or both ponds to a tanker truck in the unlikely event the pond(s) reach capacity. The requirements for a transfer pump were modeled assuming transfer from a pond to the truck load station, since this requires the highest head (the truck elevation would be higher than pumping between the ponds). The pump selected based on this criteria could transfer leachate to the other pond because the head required would be less. There is no regulatory requirement for transfer flow rate, however, it would be expected that a fairly high flow rate would be desirable to transfer flow between ponds or to a tanker truck. A pump with a flow rate of approximately 120 gpm was chosen.

3.3 Sump Volume/Pump Cycle Time

Following selection of the low-flow and high-flow LCRS, LDRS, and SLDRS pumps, it was necessary to check pump cycle time based on the available sump volume. A lengthy cycle-on time could cause excessive wear on the pump, and too short a cycle time is hard on the pumps as well. Calculations, shown in Appendix A, were performed for the pumps in both the LDRS and LCRS to determine the maximum cycle-on time to draw the sump level down to the minimum level allowed by the pump sump elevation. Note that not all of the leachate from the sump can be pumped out; any liquid below the level of the pump inlet will remain in the sump. Results show cycle times within limits for normal duty for these pump types. These times represent maximum cycle times. If desired, the cycle time may be adjusted down by resetting the pump transducer to cycle the pump on at a level in the sump less than the maximum depth allowed.

4. CREST PAD BUILDING UTILITIES

4.1 Electrical

4.1.1 Introduction

This section identifies electrical design criteria and calculations for the ICDF. An additional memorandum is included in Appendix D, which discusses the conceptual design of a process instrument and control system. Electrical demand, sizing, load flow, short circuit, and lighting calculations have been attached for the following facilities:

- Landfill Crest Pad Building
- Evaporator Pond Crest Pad Building.

4.1.2 Basic Criteria

The basic criteria for the Electrical Design are given below:

- Develop safe, reliable, and maintainable electrical systems
- Promote a consistent and uniform design approach and standardize the types and quality level of equipment specified
- Establish a uniform basis for specifications and drawings
- Provide a means of incorporating client input on items of preference and experience.

4.1.3 General Requirements

4.1.3.1 Standards and Codes

National Electrical Code (NFPA 70) 1999 (NEC)

Life Safety Code (NFPA-101-HB85)

4.1.4 Load Analysis

The attached load analysis is based upon known motor, heating, lighting, receptacle, and control equipment connections. The load analysis shall be updated during design and a final load analysis shall be prepared at completion of design.

Crest Pad Building service and equipment branch circuit ampacities shall be based upon applicable sections of NEC and as summarized in Table 4-1.

Table 4-1. Service and equipment branch circuit ampacities.

Item	Panel and Service Load Analysis	Comment
Heater Loads[a]	100% full load amperage (FLA)	Branch circuit sized to 125% of FLA
Motor Loads	Sum of motor load (FLA) + 25% of largest motor (FLA)	Branch circuit sized to 125% of FLA
Receptacles	180 VA/outlet	Non-Continuous Load
Lighting	2 watts/sq.-ft or total connected (FLA) whichever is larger	Continuous Load
Cooling Loads[a]	100% FLA	Branch circuit sized to 125% of FLA
	Demand Factors	**Demand Factor Percent**
First 10 kVA	Non-Dwelling Receptacles	125%
Remainder over 10 kVA	Non-Dwelling Receptacles	50%
Non-continuous Load		100%
Continuous Loads		125%

a. The largest of the non-coincidental heat and cooling loads shall be used for service sizing.

4.1.5 Power Distribution System

Crest Pad Buildings: Power distribution for each Crest Pad Building site shall consist of a 480-volt three-phase feeder routed from INEEL-provided power manhole to indoor floor-mounted motor control center (MCC). Indoor floor-mounted motor control center shall provide 48-volt three-phase power to 480-volt three-phase equipment in each Crest Pad Building:

- Three-phase pump motors
- Unit heaters
- Lighting panel transformers.

The lighting distribution panel shall provide 120-volt single-phase power to all single-phase equipment:

- Building lighting
- Emergency lighting
- Receptacles
- Single-phase pump motors
- Controls.

The lighting distribution panel shall provide 208/120-volt three-phase power to three-phase equipment:

- Crest Pad Building air conditioner.

4.1.5.1 ***Utilization Voltages.*** The following equipment utilization voltages are (refer to "Distribution Voltages" in this criteria for additional information):

Fluorescent lighting	120 V, 1-ϕ
Low-pressure sodium lighting	120 V, 1-ϕ
Incandescent lighting	120 V, 1-ϕ
Convenience outlets	120 V, 1-ϕ
Control system[a]	120 V, 1-ϕ
Motor control	120 V, 1-ϕ
Air conditioner	208 V, 3-ϕ
Motors, less than 1/3 hp	120 V, 1-ϕ
Motors, 1/3 hp and larger	480 V, 3-ϕ
a. Note that discrete and analog control devices shall be low voltage.	24V dc

4.1.5.2 ***Standby Power.*** Crest Pad Buildings: Power distribution system shall be configured to enable the manual transfer of electrical connected loads between normal and standby power sources. MCC inside each Crest Pad Building shall incorporate main and standby power source circuit breakers "Kirk-key" interlocked for a safe manual transfer operation.

Kirk-key interlock allows only one of the main and standby power source circuit breakers to be CLOSED at any given time. Safe manual transfer from main power to standby power source requires that the main breaker be OPENED, and the key be removed from the main power source breaker assembly and then inserted in the standby power source breaker assembly prior to CLOSING the standby power source breaker.

Safe manual transfer from the standby power source to the main power source requires that the standby power source breaker be OPENED, the key be removed and then inserted in the main power source breaker assembly prior to CLOSING the main power source breaker.

The standby power source shall consist of a portable 480-volt, 60-amp 3-phase, 4 wire-grounded standby generator provided and operated by INEEL connected to a standby generator power receptacle which in turn is hard-wired to Crest Pad Building MCC through the standby power breaker.

4.1.6 Voltage Drop

Steady-state voltage drop calculations for all heavily loaded or long circuits and feeders shall be calculated. Calculations for motor circuits shall be based on an 80% power factor. Wire size shall be determined so that circuits do not exceed the following total voltage drop from the 480-volt source bus (excluding site distribution) to the point of utilization including feeder, branch circuit, and transformation:

- Service feeder 3%
- Lighting 1%
- Motors/MCC 1%
- Fans 1%
- Receptacles 1%
- Electric heaters 1%.

4.1.7 Branch Circuits

Branch circuit breakers and conductors shall be sized using estimated connected loads and NEC requirements. Minimum wire size of No. 12 American wire gauge (AWG) copper for lighting and receptacle branch circuits shall be used. No. 10 AWG or larger (check voltage drop) shall be used where the first lighting or receptacle outlet is more than 75 ft from the lighting panel. No. 10 AWG, minimum, wiring shall be used for all outdoor circuits.

In general, lighting branch circuit loads shall be limited to 1,200 watts. Lighting and receptacle branch circuits shall not be combined. The number of receptacles on any one branch circuit shall be limited to five duplex in process areas.

4.1.8 Panelboards

Type	Designation	Configuration
Distribution MCC	MCC-CD-2179 MCC-CD-12181	480V, 3-ϕ, 3-wire
Lighting Panelboards	LP-CD-2180LP-CD-2182	120/208V, 3-ϕ, 4-wire

All branch circuits or feeders on the drawings with the panelboard and breaker protecting the individual circuit or feeder shall be identified. Each panelboard shall be sized with a minimum of 20 spare breakers with spaces, bus work, and terminations to complete the standard size panelboard.

Panelboard schedules indicating circuit identification, protective device trip rating, number of poles, load in volt amps by phase, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and interrupting rating of breakers shall be provided.

Panelboard schedules shall be prepared on a standard Excel spreadsheet template, and shall be imported onto full-size contract drawings.

4.1.9 Raceways

- 480-volt power circuits—Use standard rigid galvanized steel (RGS) and polyvinylchloride (PVC) conduit systems.
- 120-volt power circuits—Use standard RGS and electrical metallic tubing (EMT) conduit systems.

- Fiber optic circuits—Use multi-cell raceway systems.

4.1.9.1 Raceway Sizing, Selection, and Installation Guidelines

- Conduits sizes shall be based on Cross Linked Thermoset High Heat Wet Location-Rated (XHHW) insulation for wiring 600 volts and below.
- Use the following minimum sizes in the designated locations:

Minimum Raceway Size	Location
3/4-in.	Exposed on walls and ceiling.
3/4-in.	Concealed in frame construction and finished ceilings.
1-in.	Embedded in masonry or encased in concrete in buildings.
2-in.	Underground for circuits below 600 volts including telephone.
4-in.	Underground for fiber optic circuits.

4.1.9.2 Wire and Cable. Stranded copper conductors shall be used for all wiring, except lighting and receptacle circuits, where solid copper shall be used. Minimum conductor size of No. 12 shall be used for power and lighting branch circuits. Conductors installed in all branch circuits rated 100 amps or less shall have XHHW or Thermoplastic Heat Resistant Wet Location-Rated Nylon Cover (THWN) insulation with AWG size based upon NEC table for 60°C Thermoplastic Wet Location-Rated (TW) conductors.

Minimum conductor size of No. 12 AWG shall be used for individual 120-volt control circuit conductors. Under normal conditions, maximum wire size shall be limited to 350 kcmil. Parallel conductors shall be used for circuits requiring greater capacity.

4.1.9.3 Convenience Receptacles. Weatherproof/ground fault interceptor (GFI) receptacles 20-amp duplex receptacles for general service not more than 50 ft apart shall be installed in all process areas mounted on surface walls or columns.

Corrosion-resistant GFI receptacles shall be installed in damp interior areas subject to wash down, and all exterior locations.

4.1.10 Motor Protection and Control

4.1.10.1 General. For constant-speed motors 100-hp and smaller, magnetic trip-only molded case circuit breakers in full voltage combination starters shall be specified.

4.1.10.2 Overload Protection. Each motor shall be provided with thermal overload protection in all ungrounded phases. Each controller shall be provided with overload heaters and controller-mounted relay with external manual reset.

4.1.11 Grounding

Existing electrical drawings shall identify the grounding electrode system for each Crest Pad Building consisting of buried ground ring and rods.

4.1.11.1 Equipment Grounding. Noncurrent-carrying parts of all electrical equipment, devices, panelboards, and metallic raceways shall be bonded to the existing grounding system. Solidly grounded 208-volt transformer neutrals shall be bonded to the grounding system through the grounding conductor.

All conduits shall have an equipment grounding conductor. Conduits shall not be used as the equipment grounding conductor.

4.1.12 Lighting

4.1.12.1 General Requirements. Lighting fixtures shall be provided and installed to maintain an average 25-ft-candle for each Crest Pad Building's interior process area. Lighting ballasts shall be approved for 0°F starting.

4.1.12.2 Lighting Calculations. Recommended ft-candle levels for each space shall be calculated for maintained illumination per I.E.S. procedures. The following assumptions shall be made unless specific information is available:

Reflectance for finished rooms:

- Ceilings = 80% reflectance
- Walls = 50% reflectance
- Floors = 20% reflectance.

Reflectance for unfinished rooms:

- Ceilings = 80% reflectance
- Walls = 50% reflectance
- Floors = 20% reflectance.

Maintenance factor (light loss factor), interior lighting:

- Incandescent lighting = .80
- Fluorescent lighting = .61
- HPS lighting = .70.

Maintenance factor (light loss factor), exterior lighting:

- HPS lighting = .70.

4.1.12.3 Emergency Lighting System. Emergency illumination (battery-pack wall-mounted units or luminaries powered by integral battery-powered ballasts) shall be provided in all appropriate spaces as required to provide egress protection.

4.1.12.4 Circuiting and Switching. Each interior process area shall be circuited and switched so as to provide adequate lighting. Exterior building lighting shall be controlled by photocells.

4.1.12.5 Lamps and Ballasts. Energy-efficient, T8 ballasts and 32-watt lamps shall be installed in all Crest Pad Building fluorescent light fixtures. Energy-efficient, electronic multi-lamp fluorescent ballasts shall be used whenever possible.

4.1.13 Electrical Attachments (found in Appendix C)

C.1 Crest Pad Buildings Electrical Load Analysis

C.2 Crest Pad Buildings Electrical Size Analysis

C.3 Crest Pad Buildings Electrical Load Flow Analysis

C.4 Crest Pad Buildings Electrical Panel Schedule

C.5 Crest Pad Buildings Electrical Short Circuit Analysis

C.6 Crest Pad Buildings Electrical Load Analysis One-Line

C.7 Crest Pad Buildings Lighting Analysis

C.8 Crest Pad Buildings Generator Sizing Analysis.

4.2 Process Instrumentation and Control

4.2.1 Process Instrumentation and Control

4.2.1.1 General Requirements. A detailed description of the process instrumentation and control system is included in Appendix D. Refer to this appendix for a full description of the system as it is not repeated here in the main text. The process instrumentation and control system controls the function and operation of the leachate collection system. The system will be installed and adjusted to ensure the leachate collection system functions within the parameters listed herein.

4.3 Mechanical

The ICDF Landfill Crest Pad Building #1 and the Evaporator Pond Crest Pad Building contain sampling valves and pump controls for the landfill leachate sump. Design of these elements is discussed below.

4.3.1 Sampling Valves

A sampling petcock valve will be placed on a recirculation line from the leachate and leak detection sumps. The recirculation line will enable sampling by manually starting a pump at any time, without discharging to the evaporation pond force main. Samples may also be obtained from the petcock valves on the discharge lines from each pump.

4.3.2 Check Valves and Shutoff Valves

Check valves and ball shutoff valves will be installed on the discharge pipes from each of the pumps. These will prevent backflow into the discharge pipes of the other pumps when one pump is on and the others are off, and isolation for repairs and maintenance. Valves are arranged so that any pump can discharge to the recirculation line with the discharge lines from all other pumps shut off.

4.3.3 Vacuum and Vacuum-Air Relief Valves

Vacuum relief valves and air-vacuum relief valves will be located on both sides of the flow meter, as shown in the drawings, so that the discharge pipes can drain freely back into the sump (through the pump) when the pumps are shut off.

4.3.4 Flow Meters

Flow meters will be paddlewheel-type with linear response to velocity. This type of meter has been proven in landfill leachate applications, where particles may be present in the liquid flow. Maximum measurable flow rate will be as required to indicate the maximum discharge rates of the selected pumps. A flow recorder and totalizer will be included for each flow meter. There will be a separate flow meter for the discharge from each of the three pumps.

4.3.5 HVAC

Heating, ventilating, and air conditioning (HVAC) requirements were analyzed for the buildings at the Cell 1 crest pad and evaporation pond buildings. Temperature must be controlled within a range to prevent freezing or overheating conditions that could affect fluids in piping and electronic devices. The HVAC components for both buildings were chosen based on the criteria and calculations as outlined in Appendix E.

4.4 Structural

Structures for the ICDF and evaporation pond consist of the following:

- Landfill Crest Pad Building—Prefabricated, pre-engineered metal building on concrete foundation, with concrete wall at leachate riser pipe penetrations.
- Evaporation Pond Crest Pad Building—Prefabricated, pre-engineered metal building on concrete foundation, with concrete wall at leachate riser pipe penetrations.
- Truck Loading Platform—Concrete slab-on-grade adjacent to the Evaporation Pond Crest Pad Building to allow transport of leachate to and from the ponds.

Structural analysis and design of the concrete foundation and walls for the crest pad buildings and the truck loading platform was performed in accordance with DOE-ID Architectural Standards for Structural Design (DOE-ID 2000b) and DOE-STD-1020. These calculations are provided in Appendix F.

Design calculations for the prefabricated metal building will be performed by the vendor/ subcontractor for the metal building and will be submitted prior to construction for the ICDF Design. Design criteria and performance specifications for the metal building are provided in Section 13122 of the "Performance Specifications for the ICDF and Evaporation Pond" (SPC-332).

5. FORCE MAIN PIPE SIZING AND STRENGTH CALCULATIONS

The force main for leachate discharge from the landfill cell to the evaporation pond area was sized as a 3-in. carrier pipe inside an 8-in. containment pipe. Head loss and hydraulic parameters were computed for the low-flow pumps and high-flow pump planned for leachate handling and transport. Required flow rates were determined from HELP modeling as discussed herein. Head loss calculations were computed using the Darcy-Weisbach equation (Streeter and Wylie 1979). Hydraulic calculations were performed using AFT Fathom hydraulic modeling software for the various components and flow conditions. Calculations are attached in Appendix B.

Strength of the pipe was calculated for high-density polyethylene (HDPE) pipe in a manner similar to that outlined for the leachate collection pipe, above, except that live loads beneath roads were computed using the Boussinesq procedure outlined in Sharma and Lewis.

6. SECONDARY CONTAINMENT SUMP SIZE

Secondary containment piping is provided for all leachate piping located outside the limits of Cell 1 and the east and west evaporation ponds. Piping and other leachated system components within the limits of Cell 1 and the east and west evaporation ponds have secondary containment provided by the lining systems of these facilities. The secondary containment piping will drain any leakage from the carrier pipe to a leakage detection sump to be located as shown in the drawings. The volume of the containment sump is sized to handle the entire volume of the carrier piping, from the crest pad building to the evaporation pond building. Note that the secondary containment sump is distinct from the leachate detection sump. The leachate detection sump is built into the landfill to contain any leaks in the primary liner, whereas the secondary containment sump is designed to drain leakage from leachate piping.

7. REFERENCES

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